OPERATION METHOD OF SOLID POLYMER FUEL CELL

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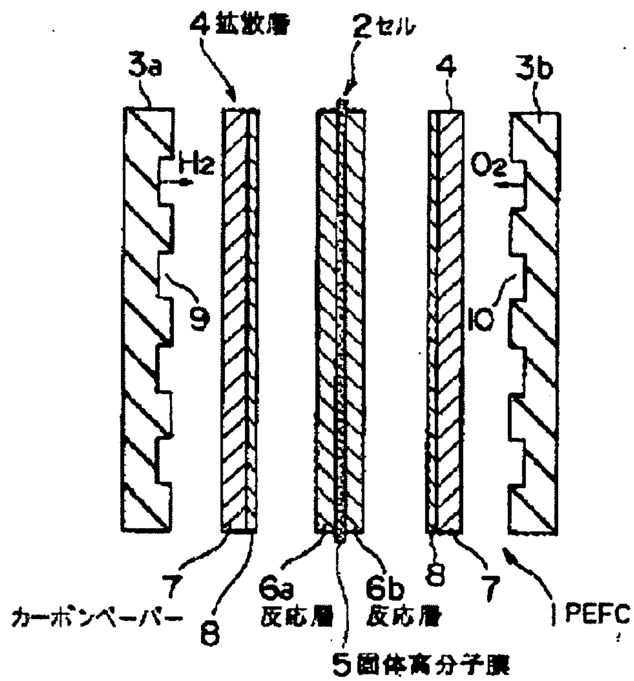
Abstract of **JP2002237320**

PROBLEM TO BE SOLVED: To provide an operation method of a solid polymer fuel cell wherein coagulation/residence of water is appropriately controlled, and PEFC cell can be made to be stably operated. SOLUTION: A membrane thickness of a polymer membrane is made to be 30 &mu m to 100 &mu m, and a cell temperature is constantly controlled as the whole cell, and the humidity at the operating cell temperature is made to be 100%, and when the relative humidity for the cell temperature of the fuel gas is taken as Y% and the relative humidity for the cell temperature of the air is taken as X%, parameters in mutual relations are set that the humidity is controlled within the optimized range surrounded by the range that Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and Y>=20X-1,600.



JAPANESE [JP,2002-237320,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Set thickness of a poly membrane to 30 micrometers or more less than 100 micrometers, and cel temperature is uniformly controlled by the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, The operating method of the polymer electrolyte fuel cell characterized by controlling humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[Claim 2] Set thickness of a poly membrane to 10 micrometers or more less than 30 micrometers, and cel temperature is uniformly controlled by the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, The operating method of the polymer electrolyte fuel cell characterized by controlling humidity to become Y<=-3/10X+140, Y>=-9/10X+100, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[Claim 3] Set thickness of a poly membrane to 30 micrometers or more less than 100 micrometers, and as there is less than 0.06 degrees C [/mm] inclination in the direction of cel temperature fang furrow length, it cools. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, The operating method of the polymer electrolyte fuel cell characterized by controlling humidity to become Y<=-3/10X+150, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1720.
[Claim 4] Set thickness of a poly membrane to 10 micrometers or more less than 30 micrometers, and as there is less than 0.06 degrees C [/mm] inclination in the direction of cel temperature fang furrow length, it cools. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, The operating method of the polymer electrolyte fuel cell characterized by controlling humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the operating method of a polymer electrolyte fuel cell (it is also called Following PEFC).
[0002]
[Description of the Prior Art] The fuel cell has acquired electromotive force by the cell reaction which obtains water from hydrogen and oxygen. The hydrogen of a raw material makes a original fuel and water, such as a methanol, react to the bottom of existence of a reforming catalyst, and is obtained. It is observed as what can demonstrate the engine performance in which PEFC was excellent among such fuel cells. In this PEFC, it is humidified in order to keep suitable the moisture content in the macromolecule of a PEFC cel. However, in checking supply of gas, having become the cause of degradation of a cel, and supplying humidification water appropriately, the problem was included when the supplied humidification water condenses and piled up within a PEFC cel. That is, if humidification water is supplied superfluously, the amount of condensation of water will increase and it will become easy to pile up. Conversely, when humidification water ran short, the moisture content in the macromolecule of a PEFC cel decreased, and there was un-arranging [that migration resistance of a proton will become large and will lead to the degradation of a PEFC cel]. Therefore, condensation and stagnation of such water were controlled appropriately, the PEFC cel was maintained good, and an improvement which operated PEFC to stability was desired.
[0003]
[Problem(s) to be Solved by the Invention] This invention is made to the above-mentioned situation, controls condensation and stagnation of water appropriately, and aims at offering the operating method of a polymer electrolyte fuel cell which enabled it to operate a PEFC cel to stability.
[0004]
[Means for Solving the Problem] The thickness of the ion exchange membrane currently used for the PEFC cel as a result of inquiring wholeheartedly so that this invention persons may attain the above-mentioned purpose, By setting it as the range which optimized five parameters of the operating temperature of a PEFC cel, the humidity (water content) of fuel gas, the humidity (water content) of air, and the temperature distribution of the direction of a flute length in mutual relation

Condensation and stagnation of water were not caused, and it found out that a fuel cell could be operated with the high engine performance maintained, without reducing the moisture content in the macromolecule of the PEFC cel depended insufficient [humidification water].
[0005] In order to attain the above-mentioned purpose, namely, this invention In the operating method of a polymer electrolyte fuel cell the thickness of a poly membrane 30 micrometers or more less than 100 micrometers, When cel temperature is uniformly controlled by the whole cel, humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0006] The operating method of the polymer electrolyte fuel cell concerning this invention 10-micrometer or more less than 30 micrometers and cel temperature are uniformly controlled for the thickness of a poly membrane by the gestalt of another operation in the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It is supposed that humidity is controlled to become Y<=-3/10X+140, Y>=-9/10X+100, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0007] The operating method of the polymer electrolyte fuel cell concerning this invention With the gestalt of another operation, the thickness of a poly membrane 30 micrometers or more less than 100 micrometers, When it cools as there is less than 0.06 degrees C [/mm] inclination in the direction of cel temperature fang furrow length, and humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+150, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1720.
[0008] The operating method of the polymer electrolyte fuel cell concerning this invention With the gestalt of another operation, the thickness of a poly membrane is cooled, as there is less than 0.06 degrees C [/mm] inclination in 30 micrometers and the direction of cel temperature fang furrow length of 10 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0009]
[Embodiment of the Invention] Below, the operating method of PEFC concerning this invention is explained further at a detail, referring to an accompanying drawing. The gestalt of 1 operation of PEFC operated by the operating method of PEFC which starts this invention at drawing 1 - drawing 3 is shown. This PEFC1 consists of a cel 2, separators 3a and 3b which are arranged at the both-ends side of this cel 2, and pinch a cel 2, and said cel 2 and the diffusion layer 4 arranged between separator 3a and 3b.

[0010] Said cel 2 consists of a solid-state poly membrane 5 and reaction layers 6a and 6b arranged at the both sides of this film 5. Said diffusion layer 4 consists of carbon paper 7 and a slurry layer 8 formed in the principal plane of one of these. The slot 9 for pouring hydrogen gas in the cel of said separator 3a is formed, and the slot 10 for passing air is formed in separator 3b of another side.
[0011] If said cel 2 is explained still more concretely, as shown in drawing 2 , reaction layer 6a consists of a fuel electrode 11 and a platinum catalyst layer 12 formed in the solid-state poly membrane 5 side. Reaction layer 6b consists of an air pole 13 and a platinum catalyst layer 12 formed in the solid-state poly membrane 5 side. Here, the following reactions are performed in a fuel electrode 11 and an air pole 13.
[0012] The following reactions are made to cause by the platinum catalyst layer 12 in a fuel electrode 11. H2 -> 2H++2e − H+ produced by this reaction is spread. On the other hand, the following reactions are made to cause by the platinum catalyst layer 12 in an air pole 13.
2H++2e−+1 / 2O2 -> H2O -- these reactions are doubled, a cell reaction is constituted and electromotive force can be acquired.
[0013] It is based on the configuration of drawing 1 and drawing 2 , and this reaction is explained further. First, fuel gas (hydrogen content gas, hydrogen gas) passes a diffusion layer 4. And the fuel electrode 11 of reaction layer 6a generates a hydrogen ion (cation). This hydrogen ion passes along the solid-state poly membrane 5, and moves to the air pole 13 of reaction layer 6b. In an air pole 13, a hydrogen ion reacts with the oxygen in air (oxygen content gas, oxidizer), and generates water.
[0014] In this PEFC, the flat-surface configuration of separator 3a (or 3b) forms the slot in the shape of meandering, as shown in drawing 3 . That is, with the gestalt of this operation, in case hydrogen gas is sent to the hole 15 for discharge on the diagonal line from the introductory hole 14 of the corner section of separator 3a, the sense of multiple-times gas is changed, for example. In addition, although it is 3 times in drawing 3 , especially the count to change is not limited.
[0015] Since water is produced at the same time it obtains power, as described above, this does not need to pile up and it is necessary to maintain the moisture content in a cel appropriately and to keep migration resistance of a proton suitable in PEFC of the above gestalten of operation. The gestalt of operation of the operating method for operating PEFC appropriately acquired as a result of this invention persons' inquiring wholeheartedly below is explained. According to the gestalt of the following operations, the moisture content in a cel is kept suitable and electromotive force can be maintained good.
[0016] The gestalt this invention persons of the 1st operation set to the operating method of a polymer electrolyte fuel cell. 30-micrometer or more less than 100 micrometers and cel temperature are uniformly controlled for the thickness of a solid-state poly membrane by the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=−3/10X+140, Y>=−11/10X+130, Y<=20X−270, and the range surrounded by Y>=20X−1600 as the

suitable control approach.
[0017] Here, fuel gas is a concept containing hydrogen content gas and hydrogen gas. Moreover, an expression called air can also be replaced with oxygen and oxygen content gas. This is the same also in other the publication of each in this specification. In order to control humidity in the above-mentioned range, it can carry out by [as adjusting the addition of the steam by the temperature or the injector of a humidification pot according to gas temperature using devices, such as a humidification pot, or a steam manufacturing installation and an injector,].
[0018] The gestalt of the 1st operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 1st operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 4 . The following things were confirmed like illustration.
(1) In the range which separates from $Y<=-3/10X+140$ (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from $Y>=-11/10X+130$ (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from $Y<=20X-270$ (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although $X-Y>=20$ 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0019] The gestalt this invention persons of the 2nd operation set to the operating method of a polymer electrolyte fuel cell. When 10-micrometer or more less than 30 micrometers and cel temperature are uniformly controlled for the thickness of a poly membrane by the whole cel, humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become $Y<=-3/10X+140$, $Y>=-9/10X+100$, $Y<=20X-270$, and the range surrounded by $Y>=20X-1600$ as the suitable control approach.
[0020] In order to control humidity in the above-mentioned range, it can carry out by [as adjusting the addition of the steam by the temperature or the injector of a humidification pot according to gas temperature using devices, such as a humidification pot, or a steam manufacturing installation and an injector,].
[0021] The gestalt of the 2nd operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt

of the 2nd operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 5 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+140 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-9/10X+100 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0022] The gestalt this invention persons of the 3rd operation set to the operating method of a polymer electrolyte fuel cell. The thickness of a poly membrane is cooled as there is less than 0.06 degrees C [/mm] inclination in less than 100 micrometers and the direction of cel temperature fang furrow length of 30 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+150, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1720 as the suitable control approach.
[0023] Although the temperature of a cel was controlled using the cooling agent which flows the inside of a separator, by considering the inlet temperature and the cooling agent flow rate of a cooling agent for the temperature gradient of the inlet temperature and outlet temperature as control, less than 0.06 degrees C [/mm] inclination was formed in the direction of cel temperature fang furrow length. In order to control humidity in the above-mentioned range, it can carry out by controlling the inlet temperature and the flow rate of a cooling agent using devices, such as a cooling agent temperature control tub, a cooling agent circulating pump, and a cooling agent flow rate controller.
[0024] The gestalt of the 3rd operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 3rd operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 6 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+150 (drawing middle point line

**), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-11/10X+130 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1720 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0025] The gestalt this invention persons of the 4th operation set to the operating method of a polymer electrolyte fuel cell. The thickness of a poly membrane is cooled as there is less than 0.06 degrees C [/mm] inclination in less than 30 micrometers and the direction of cel temperature fang furrow length of 10 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600 as the suitable control approach.
[0026] Although the temperature of a cel was controlled using the cooling agent which flows the inside of a separator, by considering the inlet temperature and the cooling agent flow rate of a cooling agent for the temperature gradient of the inlet temperature and outlet temperature as control, less than 0.06 degrees C [/mm] inclination was formed in the direction of cel temperature fang furrow length. In order to control humidity in the above-mentioned range, it can carry out by controlling the inlet temperature and the flow rate of a cooling agent using devices, such as a cooling agent temperature control tub, a cooling agent circulating pump, and a cooling agent flow rate controller.
[0027] The gestalt of the 4th operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 4th operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 7 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+140 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-11/10X+130 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the

water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0028]
[Effect of the Invention] Like [it is ****** and] from the above-mentioned place, according to this invention, condensation and stagnation of water are controlled appropriately, and the operating method of a polymer electrolyte fuel cell which enabled it to operate a PEFC cel to stability is offered.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the operating method of a polymer electrolyte fuel cell (it is also called Following PEFC).

[Translation done.]

PRIOR ART

[Description of the Prior Art] The fuel cell has acquired electromotive force by the cell reaction which obtains water from hydrogen and oxygen. The hydrogen of a raw material makes a original fuel and water, such as a methanol, react to the bottom of existence of a reforming catalyst, and is obtained. It is observed as what can demonstrate the engine performance in which PEFC was excellent among such fuel cells. In this PEFC, it is humidified in order to keep suitable the moisture content in the macromolecule of a PEFC cel. However, in checking supply of gas, having become the cause of degradation of a cel, and supplying humidification water appropriately, the problem was included when the supplied humidification water condenses and piled up within a PEFC cel. That is, if humidification water is supplied superfluously, the amount of condensation of water will increase and it will become easy to pile up. Conversely, when humidification water ran short, the moisture content in the macromolecule of a PEFC cel decreased, and there was un-arranging [that migration resistance of a proton will become large and will lead to the degradation of a PEFC cel]. Therefore, condensation and stagnation of such water were controlled appropriately, the PEFC cel was maintained good, and an improvement which operated PEFC to stability was desired.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Like [it is ****** and] from the above-mentioned place, according to this invention, condensation and stagnation of water are controlled appropriately, and the operating method of a polymer electrolyte fuel cell which enabled it to operate a PEFC cel to stability is offered.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention is made to the above-mentioned situation, controls condensation and stagnation of water appropriately, and aims at offering the operating method of a polymer electrolyte fuel cell which enabled it to operate a PEFC cel to stability.

[Translation done.]

MEANS

[Means for Solving the Problem] The thickness of the ion exchange membrane currently used for the PEFC cel as a result of inquiring wholeheartedly so that this invention persons may attain the above-mentioned purpose, By setting it as the range which optimized five parameters of the operating temperature of a PEFC cel, the humidity (water content) of fuel gas, the humidity (water content) of air, and the temperature distribution of the direction of a flute length in mutual relation Condensation and stagnation of water were not caused, and it found out that a fuel cell could be operated with the high engine performance maintained, without reducing the moisture content in the macromolecule of the PEFC cel depended insufficient [humidification water].
[0005] In order to attain the above-mentioned purpose, namely, this invention In the operating method of a polymer electrolyte fuel cell the thickness of a poly membrane 30 micrometers or more less than 100 micrometers, When cel temperature is uniformly controlled by the whole cel, humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0006] The operating method of the polymer electrolyte fuel cell concerning this invention 10-micrometer or more less than 30 micrometers and cel temperature are uniformly controlled for the thickness of a poly membrane by the gestalt of another operation in the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It is supposed that humidity is controlled to become Y<=-3/10X+140, Y>=-9/10X+100, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0007] The operating method of the polymer electrolyte fuel cell concerning this invention With the gestalt of another operation, the thickness of a poly membrane 30 micrometers or more less than 100 micrometers, When it cools as there is less than 0.06 degrees C [/mm] inclination in the direction of cel temperature fang furrow length, and humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+150, Y>=-11/10X+130, Y<=20X-270, and

the range surrounded by Y>=20X-1720.
[0008] The operating method of the polymer electrolyte fuel cell concerning this invention With the gestalt of another operation, the thickness of a poly membrane is cooled, as there is less than 0.06 degrees C [/mm] inclination in 30 micrometers and the direction of cel temperature fang furrow length of 10 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, We decided to control humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600.
[0009]
[Embodiment of the Invention] Below, the operating method of PEFC concerning this invention is explained further at a detail, referring to an accompanying drawing. The gestalt of 1 operation of PEFC operated by the operating method of PEFC which starts this invention at drawing 1 - drawing 3 is shown. This PEFC1 consists of a cel 2, separators 3a and 3b which are arranged at the both-ends side of this cel 2, and pinch a cel 2, and said cel 2 and the diffusion layer 4 arranged between separator 3a and 3b.
[0010] Said cel 2 consists of a solid-state poly membrane 5 and reaction layers 6a and 6b arranged at the both sides of this film 5. Said diffusion layer 4 consists of carbon paper 7 and a slurry layer 8 formed in the principal plane of one of these. The slot 9 for pouring hydrogen gas in the cel of said separator 3a is formed, and the slot 10 for passing air is formed in separator 3b of another side.
[0011] If said cel 2 is explained still more concretely, as shown in drawing 2 , reaction layer 6a consists of a fuel electrode 11 and a platinum catalyst layer 12 formed in the solid-state poly membrane 5 side. Reaction layer 6b consists of an air pole 13 and a platinum catalyst layer 12 formed in the solid-state poly membrane 5 side. Here, the following reactions are performed in a fuel electrode 11 and an air pole 13.
[0012] The following reactions are made to cause by the platinum catalyst layer 12 in a fuel electrode 11. H_2 -> 2H++2e - H+ produced by this reaction is spread. On the other hand, the following reactions are made to cause by the platinum catalyst layer 12 in an air pole 13.
2H++2e-+1 / 2O2 -> H_2O -- these reactions are doubled, a cell reaction is constituted and electromotive force can be acquired.
[0013] It is based on the configuration of drawing 1 and drawing 2 , and this reaction is explained further. First, fuel gas (hydrogen content gas, hydrogen gas) passes a diffusion layer 4. And the fuel electrode 11 of reaction layer 6a generates a hydrogen ion (cation). This hydrogen ion passes along the solid-state poly membrane 5, and moves to the air pole 13 of reaction layer 6b. In an air pole 13, a hydrogen ion reacts with the oxygen in air (oxygen content gas, oxidizer), and generates water.
[0014] In this PEFC, the flat-surface configuration of separator 3a (or 3b) forms the slot in the shape of meandering, as shown in drawing 3 . That is, with the gestalt of this operation, in case hydrogen gas is sent to the hole 15 for discharge on the diagonal line from the introductory hole 14 of the corner section of

separator 3a, the sense of multiple-times gas is changed, for example. In addition, although it is 3 times in drawing 3 , especially the count to change is not limited.
[0015] Since water is produced at the same time it obtains power, as described above, this does not need to pile up and it is necessary to maintain the moisture content in a cel appropriately and to keep migration resistance of a proton suitable in PEFC of the above gestalten of operation. The gestalt of operation of the operating method for operating PEFC appropriately acquired as a result of this invention persons' inquiring wholeheartedly below is explained. According to the gestalt of the following operations, the moisture content in a cel is kept suitable and electromotive force can be maintained good.
[0016] The gestalt this invention persons of the 1st operation set to the operating method of a polymer electrolyte fuel cell. 30-micrometer or more less than 100 micrometers and cel temperature are uniformly controlled for the thickness of a solid-state poly membrane by the whole cel. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600 as the suitable control approach.
[0017] Here, fuel gas is a concept containing hydrogen content gas and hydrogen gas. Moreover, an expression called air can also be replaced with oxygen and oxygen content gas. This is the same also in other the publication of each in this specification. In order to control humidity in the above-mentioned range, it can carry out by [as adjusting the addition of the steam by the temperature or the injector of a humidification pot according to gas temperature using devices, such as a humidification pot, or a steam manufacturing installation and an injector,].
[0018] The gestalt of the 1st operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 1st operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 4 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+140 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-11/10X+130 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt

of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0019] The gestalt this invention persons of the 2nd operation set to the operating method of a polymer electrolyte fuel cell. When 10-micrometer or more less than 30 micrometers and cel temperature are uniformly controlled for the thickness of a poly membrane by the whole cel, humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+140, Y>=-9/10X+100, Y<=20X-270, and the range surrounded by Y>=20X-1600 as the suitable control approach.
[0020] In order to control humidity in the above-mentioned range, it can carry out by [as adjusting the addition of the steam by the temperature or the injector of a humidification pot according to gas temperature using devices, such as a humidification pot, or a steam manufacturing installation and an injector,].
[0021] The gestalt of the 2nd operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 2nd operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 5 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+140 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-9/10X+100 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0022] The gestalt this invention persons of the 3rd operation set to the operating method of a polymer electrolyte fuel cell. The thickness of a poly membrane is cooled as there is less than 0.06 degrees C [/mm] inclination in less than 100 micrometers and the direction of cel temperature fang furrow length of 30 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the

relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+150, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1720 as the suitable control approach.
[0023] Although the temperature of a cel was controlled using the cooling agent which flows the inside of a separator, by considering the inlet temperature and the cooling agent flow rate of a cooling agent for the temperature gradient of the inlet temperature and outlet temperature as control, less than 0.06 degrees C [/mm] inclination was formed in the direction of cel temperature fang furrow length. In order to control humidity in the above-mentioned range, it can carry out by controlling the inlet temperature and the flow rate of a cooling agent using devices, such as a cooling agent temperature control tub, a cooling agent circulating pump, and a cooling agent flow rate controller.
[0024] The gestalt of the 3rd operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 3rd operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 6 . The following things were confirmed like illustration.
(1) In the range which separates from Y<=-3/10X+150 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(2) In the range which separates from Y>=-11/10X+130 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.
(4) Although X-Y>=20 1720 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.
(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.
From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.
[0025] The gestalt this invention persons of the 4th operation set to the operating method of a polymer electrolyte fuel cell. The thickness of a poly membrane is cooled as there is less than 0.06 degrees C [/mm] inclination in less than 30 micrometers and the direction of cel temperature fang furrow length of 10 micrometers or more. When humidity in operation cel temperature is made into 100% and relative humidity [as opposed to the cel temperature of air for the relative humidity to the cel temperature of fuel gas] is made into X % Y%, It found out controlling humidity to become Y<=-3/10X+140, Y>=-11/10X+130, Y<=20X-270, and the range surrounded by Y>=20X-1600 as the suitable control approach.
[0026] Although the temperature of a cel was controlled using the cooling agent

which flows the inside of a separator, by considering the inlet temperature and the cooling agent flow rate of a cooling agent for the temperature gradient of the inlet temperature and outlet temperature as control, less than 0.06 degrees C [/mm] inclination was formed in the direction of cel temperature fang furrow length. In order to control humidity in the above-mentioned range, it can carry out by controlling the inlet temperature and the flow rate of a cooling agent using devices, such as a cooling agent temperature control tub, a cooling agent circulating pump, and a cooling agent flow rate controller.

[0027] The gestalt of the 4th operation is carried out and the result of having controlled the moisture content in a cel appropriately, and the result of the gestalt of the 4th operation having been out of range, and having controlled the moisture content in a cel appropriately are shown as contrasted with drawing 7 . The following things were confirmed like illustration.

(1) In the range which separates from Y<=-3/10X+140 (drawing middle point line **), although sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.

(2) In the range which separates from Y>=-11/10X+130 (alternate long and short dash line in drawing **), although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.

(3) it separates from Y<=20X-270 (alternate long and short dash line in drawing **) -- coming out -- although there was no puddle phenomenon, since the water content of the solid-state macromolecule component in an electrode and a solid-state poly membrane fell and ion conductivity became low, sag exceeded 4%.

(4) Although X-Y>=20 1600 (drawing middle point line **) sag was less than 4%, the uniform gas supply to a lifting electrode is barred in a puddle phenomenon, and it leads to breakage of a cel.

(5) The field surrounded by above-mentioned line ** to ** concerning the gestalt of this operation showed the good generation-of-electrical-energy property.

From the above thing, it is understood by the operating method concerning the gestalt of this operation that it is the range which the parameter optimized in mutual relation.

[Translation done.]

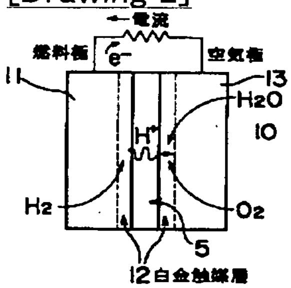
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing notionally the gestalt of 1 operation of PEFC which enforces the operating method of PEFC concerning this invention.
[Drawing 2] It is a conceptual diagram explaining the generation-of-electrical-energy principle of PEFC which enforces the operating method of PEFC concerning this invention.
[Drawing 3] It is the top view which explains the cellular structure about the gestalt of 1 operation of PEFC which enforces the operating method of PEFC concerning this invention.
[Drawing 4] It is the graph which shows the optimum control range of the gestalt of the 1st operation about the operating method of PEFC concerning this invention.
[Drawing 5] It is the graph which shows the optimum control range of the gestalt of the 2nd operation about the operating method of PEFC concerning this invention.
[Drawing 6] It is the graph which shows the optimum control range of the gestalt of the 3rd operation about the operating method of PEFC concerning this invention.
[Drawing 7] It is the graph which shows the optimum control range of the gestalt of the 4th operation about the operating method of PEFC concerning this invention.
[Description of Notations]
1 PEFC
2 Cel
3a, 3b Separator
4 Diffusion Layer
5 Solid-state Poly Membrane
6a, 6b Reaction layer
7 Carbon Paper
9 Slot
11 Fuel Electrode
12 Platinum Catalyst Layer
13 Air Pole
14 Introductory Hole
15 Hole for Discharge

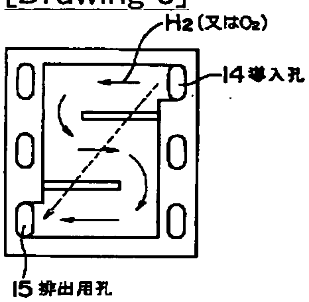
[Translation done.]

DRAWINGS

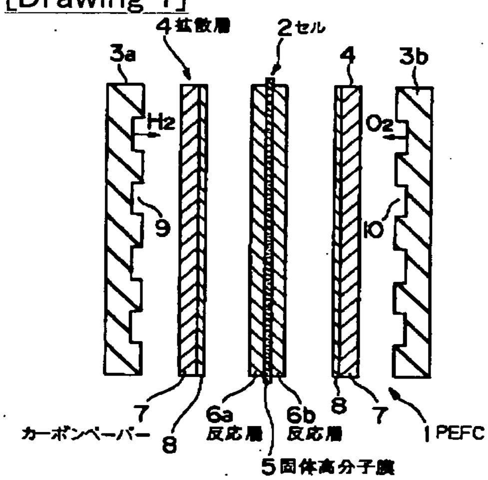
[Drawing 2]



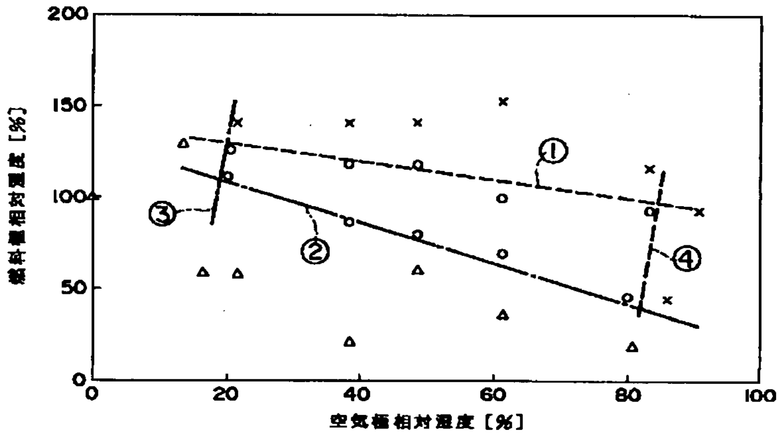
[Drawing 3]



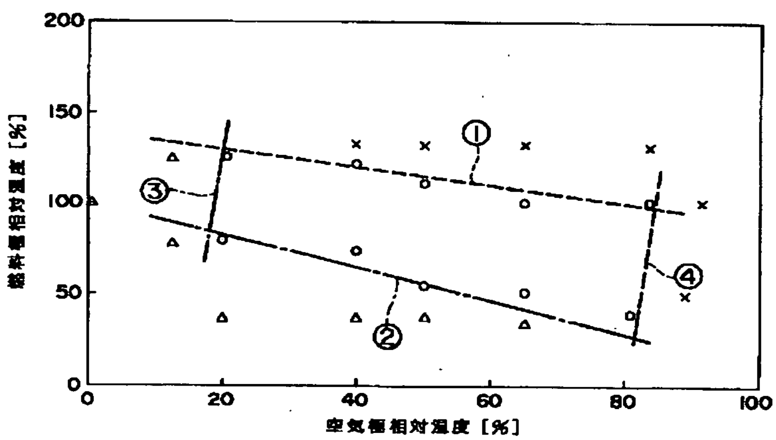
[Drawing 1]



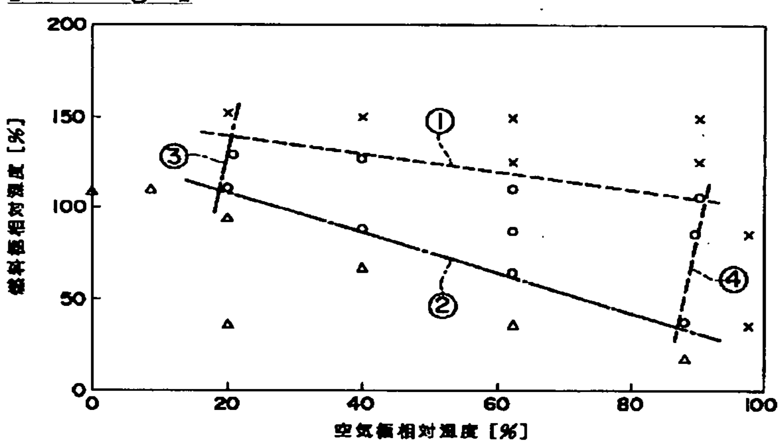
[Drawing 4]



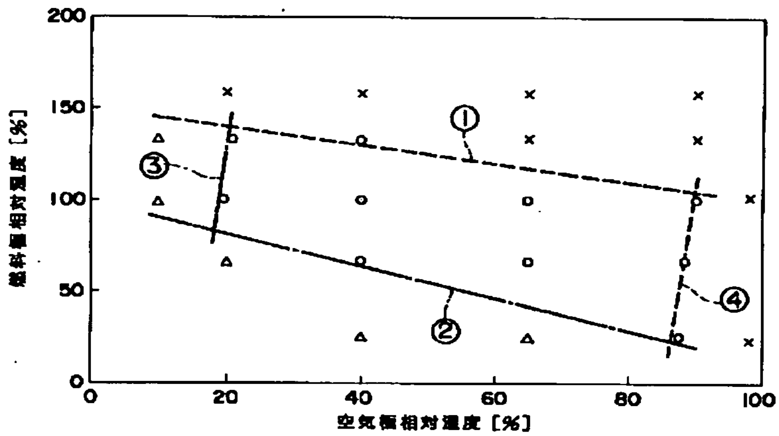
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]

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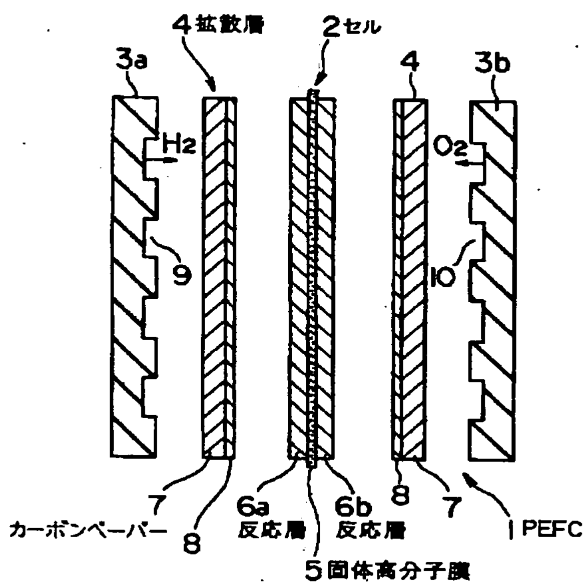
最終頁に続く

(54)【発明の名称】　固体高分子型燃料電池の運転方法

(57)【要約】
【課題】　水の凝集・滞留を適切に制御し、ＰＥＦＣセルを安定に運転することができるようにした固体高分子型燃料電池の運転方法を提供する。
【解決手段】　高分子膜の膜厚を３０μｍ以上１００μｍ未満とし、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御するといったように、パラメータを相互の関係において最適化した範囲に設定することとした。



【特許請求の範囲】
【請求項１】　高分子膜の膜厚を３０μm以上１００μm未満とし、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することを特徴とする固体高分子型燃料電池の運転方法。
【請求項２】　高分子膜の膜厚を１０μm以上３０μm未満とし、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－９／１０Ｘ＋１００、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することを特徴とする固体高分子型燃料電池の運転方法。
【請求項３】　高分子膜の膜厚を３０μm以上１００μm未満とし、セル温度が溝長方向で０．０６℃／mm以内の勾配があるように冷却し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１５０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１７２０で囲まれる範囲となるように湿度を制御することを特徴とする固体高分子型燃料電池の運転方法。
【請求項４】　高分子膜の膜厚を１０μm以上３０μm未満とし、セル温度が溝長方向で０．０６℃／mm以内の勾配があるように冷却し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することを特徴とする固体高分子型燃料電池の運転方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、固体高分子型燃料電池（以下ＰＥＦＣともいう）の運転方法に関する。
【０００２】
【従来の技術】燃料電池は、水素と酸素から水を得る電池反応によって起電力を得ている。原料の水素は、メタノールなどの原燃料と水を改質触媒の存在下に反応させて得られる。このような燃料電池のうち、ＰＥＦＣが優れた性能を発揮できるものとして注目されている。かかるＰＥＦＣでは、ＰＥＦＣセルの高分子中の含水量を適切に保つために加湿されている。ところが、供給された加湿水がＰＥＦＣセル内で凝縮・滞留することにより、ガスの供給が阻害されてセルの劣化の原因となっており、加湿水の供給を適切に行うにあたって問題を含んでいた。すなわち、加湿水を過剰に供給すると、水の凝縮量が多くなり、滞留しやすくなる。逆に加湿水が不足すると、ＰＥＦＣセルの高分子中の含水量が少なくなり、プロトンの移動抵抗が大きくなってＰＥＦＣセルの性能低下につながってしまうという不都合があった。したがって、このような水の凝集・滞留を適切に制御し、ＰＥＦＣセルを良好に維持し、ＰＥＦＣを安定に運転するようにした改善が望まれていた。
【０００３】
【発明が解決しようとする課題】本発明は、上記事情に対してなされたものであり、水の凝集・滞留を適切に制御し、ＰＥＦＣセルを安定に運転することができるようにした固体高分子型燃料電池の運転方法を提供することを目的とする。
【０００４】
【課題を解決するための手段】本発明者らは、上記目的を達成するべく鋭意検討した結果、ＰＥＦＣセルに使用されているイオン交換膜の厚さ、ＰＥＦＣセルの運転温度、燃料ガスの湿度（含水率）、空気の湿度（含水率）、溝長さ方向の温度分布の５つのパラメータを相互の関係において最適化した範囲に設定することで、水の凝集・滞留を起こさず、かつ、加湿水不足によるＰＥＦＣセルの高分子中の含水量を減らすことなく、高い性能を保ったまま燃料電池を運転できることを見出した。
【０００５】すなわち、上記目的を達成するために、本発明は、固体高分子型燃料電池の運転方法において、高分子膜の膜厚を３０μm以上１００μm未満、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することとした。
【０００６】本発明に係る固体高分子型燃料電池の運転方法は、別の実施の形態で、高分子膜の膜厚を１０μm以上３０μm未満、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－９／１０Ｘ＋１００、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することとしている。
【０００７】本発明に係る固体高分子型燃料電池の運転方法は、別の実施の形態で、高分子膜の膜厚を３０μm以上１００μm未満、セル温度が溝長方向で０．０６℃／mm以内の勾配があるように冷却し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１５０、Ｙ≧－１１／

１０Ｘ＋１３０、Ｙ≦２０Ｘ−２７０、Ｙ≧２０Ｘ−１７２０で囲まれる範囲となるように湿度を制御することとした。

【０００８】本発明に係る固体高分子型燃料電池の運転方法は、別の実施の形態で、高分子膜の膜厚を１０μｍ以上３０μｍ、セル温度が溝長方向で０．０６℃／ｍｍ以内の勾配があるように冷却し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦−３／１０Ｘ＋１４０、Ｙ≧−１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ−２７０、Ｙ≧２０Ｘ−１６００で囲まれる範囲となるように湿度を制御することとした。

【０００９】

【発明の実施の形態】以下に、本発明に係るＰＥＦＣの運転方法について、添付図面を参照しながらさらに詳細に説明する。図１〜図３に、本発明に係るＰＥＦＣの運転方法によって運転されるＰＥＦＣの一実施の形態を示す。このＰＥＦＣ１は、セル２と、このセル２の両端側に配置されてセル２を挟持するセパレータ３ａ，３ｂと、前記セル２とセパレータ３ａ，３ｂ間に配置された拡散層４とから構成されている。

【００１０】前記セル２は、固体高分子膜５と、該膜５の両側に配置された反応層６ａ，６ｂとから構成されている。前記拡散層４は、カーボンペーパー７と、この一方の主面に形成されたスラリー層８とから構成されている。前記セパレータ３ａのセルには水素ガスを流すための溝９が形成され、他方のセパレータ３ｂには、空気を流すための溝１０が形成されている。

【００１１】前記セル２を更に具体的に説明すると、図２に示すように、反応層６ａは、燃料極１１と固体高分子膜５側に形成された例えば白金触媒層１２とから構成されている。反応層６ｂは、空気極１３と固体高分子膜５側に形成された例えば白金触媒層１２とから構成されている。ここで、燃料極１１、空気極１３では、下記のような反応が行われる。

【００１２】燃料極１１において白金触媒層１２により、以下の反応を起こさせる。$H_2 \rightarrow 2H^+ + 2e^-$ この反応によって生じるH^+が拡散する。一方、空気極１３において白金触媒層１２により、以下の反応を起こさせる。

$2H^+ + 2e^- + 1/2O_2 \rightarrow H_2O$

これらの反応を合わせて電池反応が構成され、起電力を得ることができる。

【００１３】この反応を図１、図２の構成に即してさらに説明する。まず、燃料ガス（水素含有ガス、水素ガス）が、拡散層４を通過する。そして、反応層６ａの燃料極１１で水素イオン（陽イオン）を生成する。この水素イオンは、固体高分子膜５を通って、反応層６ｂの空気極１３に移動する。空気極１３では、水素イオンが空気（酸素含有ガス、酸化剤）中の酸素と反応して水を生成する。

【００１４】このＰＥＦＣでは、セパレータ３ａ（又は３ｂ）の平面形状は、図３に示すように溝を蛇行状に形成している。すなわち、本実施の形態では、例えば、水素ガスをセパレータ３ａのコーナー部の導入孔１４から対角線上の排出用孔１５へ送る際に、複数回ガスの向きを変えている。なお、図３では３回であるが、変える回数は、特に限定されるものではない。

【００１５】上記のような実施の形態のＰＥＦＣでは、前記したように電力を得ると同時に水を生じるので、これが滞留せず、かつ、セル内の含水量を適切に維持してプロトンの移動抵抗を適切に保つ必要がある。以下に、本発明者らが鋭意検討した結果得られた、ＰＥＦＣを適切に運転するための運転方法の実施の形態を説明する。以下の実施の形態によれば、セル内の含水量が適切に保たれ、起電力を良好に維持することができる。

【００１６】第１の実施の形態

本発明者らは、固体高分子型燃料電池の運転方法において、固体高分子膜の膜厚を３０μｍ以上１００μｍ未満、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦−３／１０Ｘ＋１４０、Ｙ≧−１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ−２７０、Ｙ≧２０Ｘ−１６００で囲まれる範囲となるように湿度を制御することを、適切な制御方法として見出した。

【００１７】ここで、燃料ガスとは、水素含有ガス、水素ガスを含む概念である。また、空気という表現は、酸素、酸素含有ガスと置き換えることもできる。このことは、本明細書中の他の各記載においても同様である。湿度を上記範囲に制御するためには、加湿ポットもしくは水蒸気製造装置とインジェクタといった機器を用いてガス温度に応じて加湿ポットの温度もしくはインジェクタによる水蒸気の添加量を調節するようにして行うことができる。

【００１８】第１の実施の形態を実施して、セル内の含水量を適切に制御した結果と、第１の実施の形態の範囲外でセル内の含水量を適切に制御した結果とを、図４に対比して示す。図示のように、以下のことが確かめられた。

（１）Ｙ≦−３／１０Ｘ＋１４０（図中点線①）を外れる範囲では、電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。

（２）Ｙ≧−１１／１０Ｘ＋１３０（図中一点鎖線②）を外れる範囲では、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。

（３）Ｙ≦２０Ｘ－２７０（図中一点鎖線③）を外れるでは、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。
（４）Ｙ≧２０Ｘ－１６００（図中点線④）電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。
（５）本実施の形態に係る上記線①から④で囲まれた領域は、良好な発電特性を示した。
以上のことから、本実施の形態に係る運転方法では、パラメータが相互の関係において最適化した範囲であることが了解される。
【００１９】第２の実施の形態
本発明者らは、固体高分子型燃料電池の運転方法において、高分子膜の膜厚を１０μｍ以上３０μｍ未満、セル温度をセル全体で一定に制御し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－９／１０Ｘ＋１００、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することを、適切な制御方法として見出した。
【００２０】湿度を上記範囲に制御するためには、加湿ポットもしくは水蒸気製造装置とインジェクタといった機器を用いてガス温度に応じて加湿ポットの温度もしくはインジェクタによる水蒸気の添加量を調節するようにして行うことができる。
【００２１】第２の実施の形態を実施して、セル内の含水量を適切に制御した結果と、第２の実施の形態の範囲外でセル内の含水量を適切に制御した結果とを、図５に対比して示す。図示のように、以下のことが確かめられた。
（１）Ｙ≦－３／１０Ｘ＋１４０（図中点線①）を外れる範囲では、電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。
（２）Ｙ≧－９／１０Ｘ＋１００（図中一点鎖線②）を外れる範囲では、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。
（３）Ｙ≦２０Ｘ－２７０（図中一点鎖線③）を外れるでは、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。
（４）Ｙ≧２０Ｘ－１６００（図中点線④）電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。
（５）本実施の形態に係る上記線①から④で囲まれた領域は、良好な発電特性を示した。
以上のことから、本実施の形態に係る運転方法では、パラメータが相互の関係において最適化した範囲であることが了解される。
【００２２】第３の実施の形態
本発明者らは、固体高分子型燃料電池の運転方法において、高分子膜の膜厚を３０μｍ以上１００μｍ未満、セル温度が溝長方向で０．０６℃／ｍｍ以内の勾配があるように冷却し、運転セル温度での湿度を１００％とし、燃料ガスのセル温度に対する相対湿度をＹ％、空気のセル温度に対する相対湿度をＸ％としたとき、Ｙ≦－３／１０Ｘ＋１５０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１７２０で囲まれる範囲となるように湿度を制御することを、適切な制御方法として見出した。
【００２３】セパレータ内を流れる冷却剤を用いてセルの温度を制御するがその入口温度と出口温度の温度差を冷却剤の入口温度及び冷却剤流量を制御とすることにより、セル温度が溝長方向で０．０６℃／ｍｍ以内の勾配を形成した。湿度を上記範囲に制御するためには、冷却剤温度制御槽、冷却剤循環ポンプ、冷却剤流量コントローラといった機器を用いて冷却剤の入口温度及び流量を制御することによって、行うことができる。
【００２４】第３の実施の形態を実施して、セル内の含水量を適切に制御した結果と、第３の実施の形態の範囲外でセル内の含水量を適切に制御した結果とを、図６に対比して示す。図示のように、以下のことが確かめられた。
（１）Ｙ≦－３／１０Ｘ＋１５０（図中点線①）を外れる範囲では、電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。
（２）Ｙ≧－１１／１０Ｘ＋１３０（図中一点鎖線②）を外れる範囲では、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。
（３）Ｙ≦２０Ｘ－２７０（図中一点鎖線③）を外れるでは、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４％を超えた。
（４）Ｙ≧２０Ｘ－１７２０（図中点線④）電圧低下は、４％以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。
（５）本実施の形態に係る上記線①から④で囲まれた領域は、良好な発電特性を示した。
以上のことから、本実施の形態に係る運転方法では、パラメータが相互の関係において最適化した範囲であることが了解される。
【００２５】第４の実施の形態
本発明者らは、固体高分子型燃料電池の運転方法において、高分子膜の膜厚を１０μｍ以上３０μｍ未満、セル

温度が溝長方向で０．０６℃／mm以内の勾配があるように冷却し、運転セル温度での湿度を１００%とし、燃料ガスのセル温度に対する相対湿度をＹ%、空気のセル温度に対する相対湿度をＸ%としたとき、Ｙ≦－３／１０Ｘ＋１４０、Ｙ≧－１１／１０Ｘ＋１３０、Ｙ≦２０Ｘ－２７０、Ｙ≧２０Ｘ－１６００で囲まれる範囲となるように湿度を制御することを、適切な制御方法として見出した。

【００２６】セパレータ内を流れる冷却剤を用いてセルの温度を制御するがその入口温度と出口温度の温度差を冷却剤の入口温度及び冷却剤流量を制御とすることにより、セル温度が溝長方向で０．０６℃／mm以内の勾配を形成した。湿度を上記範囲に制御するためには、冷却剤温度制御槽、冷却剤循環ポンプ、冷却剤流量コントローラといった機器を用いて冷却剤の入口温度及び流量を制御することによって、行うことができる。

【００２７】第４の実施の形態を実施して、セル内の含水量を適切に制御した結果と、第４の実施の形態の範囲外でセル内の含水量を適切に制御した結果とを、図７に対比して示す。図示のように、以下のことが確かめられた。

（１）Ｙ≦－３／１０Ｘ＋１４０（図中点線①）を外れる範囲では、電圧低下は、４%以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。

（２）Ｙ≧－１１／１０Ｘ＋１３０（図中一点鎖線②）を外れる範囲では、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４%を超えた。

（３）Ｙ≦２０Ｘ－２７０（図中一点鎖線③）を外れるでは、水溜り現象がなかったものの、電極中の固体高分子成分及び固体高分子膜の含水率が低下してイオン導電性が低くなるため電圧低下が４%を超えた。

（４）Ｙ≧２０Ｘ－１６００（図中点線④）電圧低下は、４%以内であったが、水溜り現象を起こし電極への均一なガス供給が妨げられてセルの破損につながる。

（５）本実施の形態に係る上記線①から④で囲まれた領域は、良好な発電特性を示した。

以上のことから、本実施の形態に係る運転方法では、パラメータが相互の関係において最適化した範囲であることが了解される。

【００２８】

【発明の効果】上記したところから明かなように、本発明によれば、水の凝集・滞留を適切に制御し、ＰＥＦＣセルを安定に運転することができるようにした固体高分子型燃料電池の運転方法が提供される。

【図面の簡単な説明】

【図１】本発明に係るＰＥＦＣの運転方法を実施するＰＥＦＣの一実施の形態を概念的に示す断面図である。

【図２】本発明に係るＰＥＦＣの運転方法を実施するＰＥＦＣの発電原理を説明する概念図である。

【図３】本発明に係るＰＥＦＣの運転方法を実施するＰＥＦＣの一実施の形態について、セル構造を説明する平面図である。

【図４】本発明に係るＰＥＦＣの運転方法について、第１の実施の形態の最適制御範囲を示すグラフである。

【図５】本発明に係るＰＥＦＣの運転方法について、第２の実施の形態の最適制御範囲を示すグラフである。

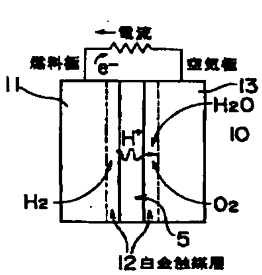
【図６】本発明に係るＰＥＦＣの運転方法について、第３の実施の形態の最適制御範囲を示すグラフである。

【図７】本発明に係るＰＥＦＣの運転方法について、第４の実施の形態の最適制御範囲を示すグラフである。

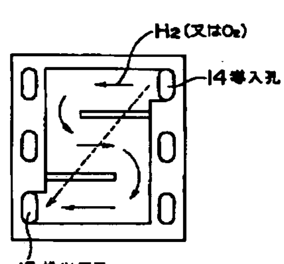
【符号の説明】

１	ＰＥＦＣ
２	セル
３ａ，３ｂ	セパレータ
４	拡散層
５	固体高分子膜
６ａ，６ｂ	反応層
７	カーボンペーパー
９	溝
１１	燃料極
１２	白金触媒層
１３	空気極
１４	導入孔
１５	排出用孔

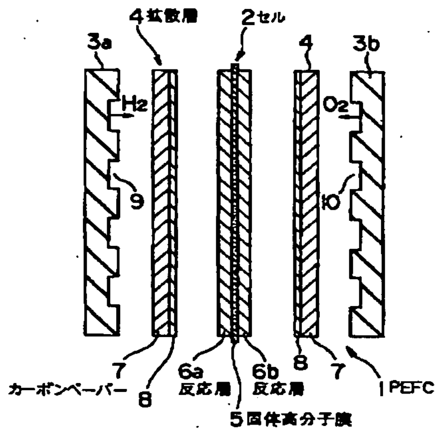
【図２】



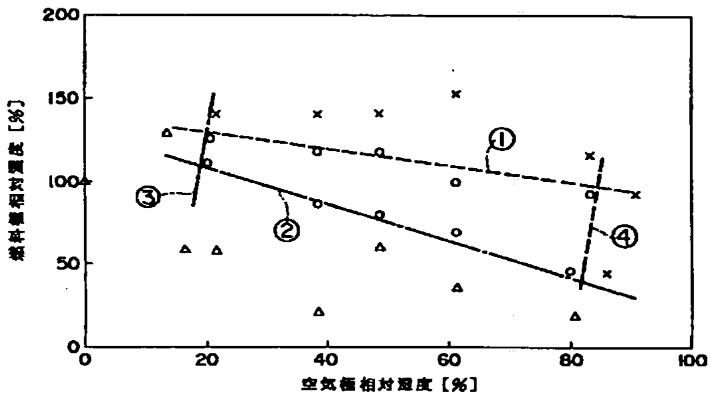
【図３】



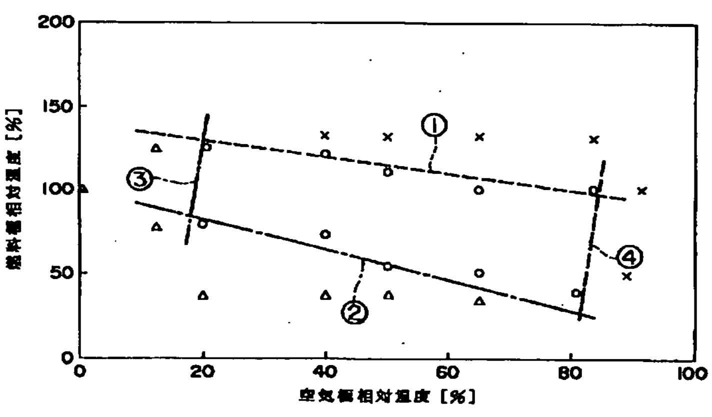
【図１】


4拡散層
2セル
3a
4
3b
H2
O2
9
10
7
カーボンペーパー
8
6a
反応層
6b
反応層
8
7
1 PEFC
5固体高分子膜

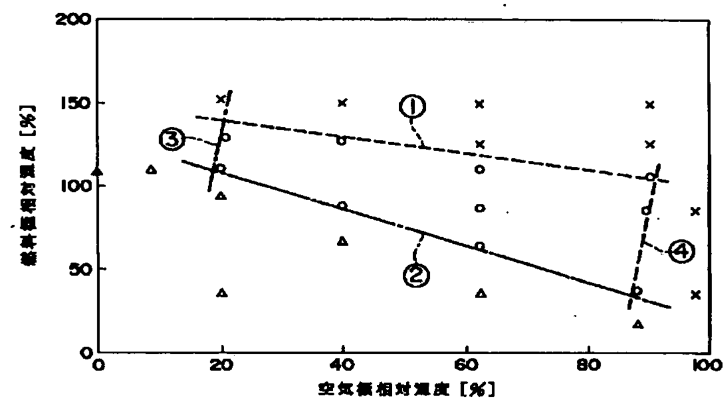
【図４】


燃料極相対湿度［%］
空気極相対湿度［%］
200
150
100
50
0
0
20
40
60
80
100
①
②
③
④

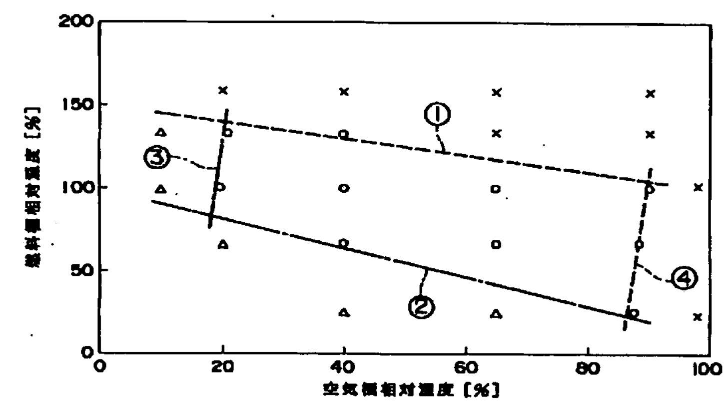
【図５】


燃料極相対湿度［%］
空気極相対湿度［%］
200
150
100
50
0
0
20
40
60
80
100
①
②
③
④

【図６】



【図７】



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5H027 AA06 KK31